in regression rate observed in these fuels, and to demonstrate the effect of increased regression rate on hybrid rocket motor performance. At the time of this reporting, more than 400 motor tests were conducted with a variety of oxidizers ($N_2O$, GOx, LOx) at ever increasing scales with thrust levels from 5 to over 15,000 pounds (22 N to over 66 kN) in order to move this technology from the laboratory to practical applications.

The Peregrine program is the natural next step in this development. A number of small sounding rockets with diameters of 3, 4, and 6 in. (7.6, 10.2, and 15.2 cm) have been flown, but Peregrine at a diameter of 15 in. (38.1 cm) and 14,000-lb (62.3-kN) thrust is by far the largest system ever attempted and will be one of the largest hybrids ever flown. Successful Peregrine flights will set the stage for a wide range of applications of this technology. The metrics of the program are:

- Demonstrate satisfactory motor performance in ground test.
- Demonstrate motor throttling in ground test.
- Fabricate the sounding rocket system, transport it to the NASA Wallops facility, and launch a payload to 100 km using paraffin and $N_2O$ as the propellants.
- Demonstrate operational efficiency at the Wallops launch site.

*This work was done by Gregory Zilliac of Ames Research Center. Further information is contained in a TSP (see page 1).*

*Inquiries concerning rights for commercial use of this invention should be addressed to the Ames Technology Partnerships Division at (650) 604-5761. Refer to ARC-16240-1.*

# SOFIA Closed- and Open-Door Aerodynamic Analyses

## A series of important evaluations are completed.

*Dryden Flight Research Center, Edwards, California*

Work to evaluate the aerodynamic characteristics and the cavity acoustic environment of the SOFIA (Stratospheric Observatory for Infrared Astronomy) airplane has been completed. The airplane has been evaluated in its closed-door configuration, as well as several open-door configurations (see figure). Work performed included: acoustic analysis tool development, cavity acoustic evaluation, stability and control parameter estimation, air data calibration, and external flow evaluation.

Cavity acoustics were evaluated using measured pressure data. Of primary interest were sound pressure levels and frequency response curves. Analysis tools were primarily written for MATLAB. Several tools were developed to allow rapid analysis of acoustic data, giving engineers the ability to calculate and examine results from acoustic sensors in and around the telescope cavity. A batch analysis capability was created so that analysts could process data from an entire flight with one command.

Significant effort was put into completing the evaluation of the aerodynamic characteristics of the modified 747SP airplane in closed-door and open-door configurations. Parameter identification maneuvers were designed and then performed during closed and open door flight tests. Parameter estimation data analysis techniques were used in conjunction with existing aerodynamic models to create aerodynamic models for various airplane configurations. Any differences between configurations were examined.

Air data calibration maneuvers were also flown and calibrations were developed for the various air data systems, including the airplane pitot static system and a Flush Air Data Sensing (FADS) system. Results were compared for different door configurations, to determine if door position affected air data measurements.

Qualitative airflow data were obtained during the closed- and open-door flights using tufts on the aft portion of the fuselage. Video was taken from a chase plane. This video was analyzed for various flight conditions, and general flow descriptions of the aft fuselage of the 747SP were developed for the different closed and open door configurations.

*This work was done by Stephen Cumming, Mike Frederick, and Mark Smith of Dryden Flight Research Center. For further information, contact Yvonne D. Gibbs at yvonne.d.gibbs@nasa.gov. DRC-010-016*


Photo of **747SP SOFIA Airplane** undergoing tests in an open-door configuration.